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Coordinating Efforts in Virtual Communities: Examining Network Governance in Open Source

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ABSTRACT

While there is growing interest in the phenomenon of virtual communities, to date we know little about the structural dynamics underlying one type of virtual community, open source software communities. Open source communities (OSCs) are used to coordinate the voluntary efforts of members to create complex software products. We propose that OSCs utilize a network form of governance to coordinate activities to ensure collective interests are achieved. In contrast to the formal exchange structures of market transactions based on contracts and bureaucratic structures based on hierarchical controls, network structures are an alternative governance form based on social interactions and informal controls. In this paper, we present a theoretical model examining network governance in OSCs, and suggest that OSC project success is dependent upon the ability of individuals to coordinate and safeguard interactions, which is enhanced by the use of social controls. We conclude by presenting our strategy for empirically testing the theoretical model.

KEYWORDS

Open source software, virtual communities, network governance

INTRODUCTION

Advances in network technologies enable individuals to communicate free from the constraints of same place and/or same time communication, and have led to the creation of virtual communities. Virtual communities have been defined as “groups of people with common interests and practices that communicate regularly and for some duration in an organized way over the Internet” (Ridings, Gefen, & Arinze, 2002, pg. 272). The technology creates a virtual meeting space where people exchange ideas, share personal experience, and help one another solve problems. Virtual communities have developed to support informal knowledge exchange within organizations (Constant, Sproull, & Kiesler, 1996), provide customer support for organizations (Gu & Jarvenpaa, 2003), support knowledge exchange across organizations (Ahuja, Galletta, & Carley, 2003) and encourage open discussion and knowledge exchange in communities without organizational affiliation, such as Usenet newsgroups (Ridings et al., 2002).

Virtual communities are not only useful for supporting knowledge exchange between participants, but are also useful for coordinating knowledge work to achieve a specific outcome, such as open source software development (von Hippel & von Krogh, 2003). Open source software, according to the community accepted definition, is software to which the source code is freely available and modifiable (<http://www.opensource.org>). In contrast to proprietary software development, open source software development is typically performed by volunteers. In an open source community (OSC), programmers, testers, and users of the software contribute to the growth of the software by writing and testing code, reporting bugs, adding features, and writing documentation. Additionally, many open source projects have mailing lists or web forums to discuss software development and use. OSC volunteers may participate or leave at any time, and work is coordinated without formal contracts. Tasks are usually chosen based on ability or “passion” rather than designated or assigned (Raymond, 1999). The manner of coordination of work varies between projects, but often, one individual or small group coordinates work by volunteers. But how do OSCs manage the work of potentially hundreds of volunteers without formal structures? This research aims to shed light on this question.

The goal of this research in progress is to present a theoretical framework to examine the coordination of work through informal network structures. We propose that OSCs are able to coordinate actions through the informal social mechanisms that are created by individual interactions in a network. We then present our strategy for testing the model empirically. This research is important because it advances our understanding of how virtual communities can be used to create specific knowledge work outcomes, and how voluntary work can be managed through informal social mechanisms.

THEORETICAL MODEL

A generalized theory of network governance was first proposed by Jones, Hesterly and Borgatti (1997). Networks are characterized by nodes and the connecting relationships between nodes. Nodes can be any type of entity such as technologies, objects, individuals, collectives, or organizations. For this research, we are interested in the network of individuals within an OSC. We adapt the definition of network governance proposed by Jones et. al. (1997) as involving “a set of autonomous individuals engaged in creating products or services based on implicit and open-ended contracts to adapt to environmental contingencies and to coordinate and safeguard exchanges. These contracts are socially – not legally – binding” (Jones et al., 1997 pg. 914). In a network of loosely coupled individuals, coordination and cooperation rely on informal social systems rather than bureaucratic structures and contracts. Since these informal controls have the same purpose as formal agreements, namely, safeguarding and coordinating exchanges, network governance is a viable alternative to bureaucratic structures and emerges when it is more efficient than other forms of governance (Jones et al., 1997).

Theories of network governance are applicable to OSCs since OSCs consist of volunteers organized into informal communities, without formal ties, who are engaged in creating software. Participants in the OSC exchange knowledge and code, and these exchanges need to be coordinated towards a specific goal as well as safeguarded against acts of self-interest. We adapt the model from Jones et al. (1997) to propose that the network characteristics of structural and relational embeddedness foster the creation of informal social mechanisms consisting of: restricted access, macroculture, collective sanctions, and reputation (Figure 1). These informal social mechanisms enhance the coordination of efforts and encourage the safeguarding of exchanges among members of the OSC. In turn, better coordination and safeguarding increase project success. Thus, we are interested in determining whether differences in network governance at the network level (rather than individual level) influence the success of open source projects. Each of the constructs is discussed below.

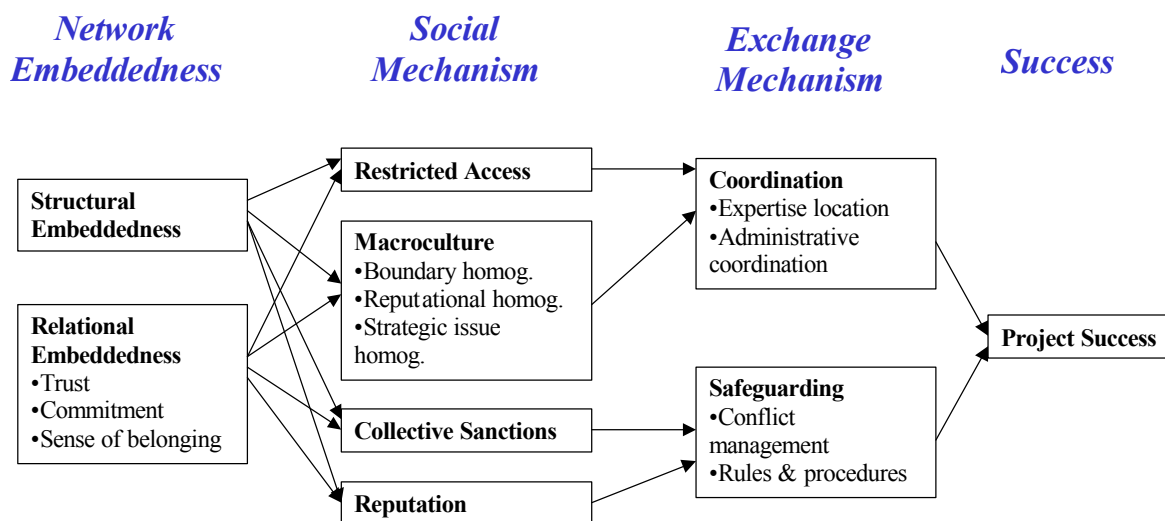


Figure 1 – Theoretical Model of Network Governance in Open Source Communities

EMPIRICAL MODEL

Sample and Procedures

The OSCs for this study will be selected from the Sourceforge website. Sourceforge is the world’s largest OSC development website and hosts 76,358 OSCs with over 795,000 registered members (<http://sourceforge.net>). We limited our sample to Sourceforge communities in order to standardize data collection. Communities will be selected based on the following criteria. First, the communities need a forum where members actively communicate, so the initial communities will be selected from Sourceforge’s 100 most active forums list. We will select only those communities that have an “Open Discussion” forum, and no independent forums available through another website. The “Open Discussion” forums will be reviewed to ensure that at least 10 thread messages have been posted during a six-week period.

These criteria should result in approximately 50 OSCs, which will be adequate for testing our model using PLS (partial least squares). PLS requires a sample size consisting of ten times the number of predictors from either the indicators on the most complex formative construct, or the largest number of antecedent constructs leading to an endogenous construct, whichever is greater. Objective data will be collected from the website to determine the number and roles of project developers, and to assess project success. Messages from the “Open Discussion” forums will be analyzed to create a list of active project members, and these members will be asked to complete an electronic survey. The survey is based on measures that were adapted from previously published studies. The list of actual items and their sources is available upon request from

the first author.

Constructs and Measures

Structural embeddedness refers to the overall structure of the network, and is defined as the extent to which a dyad's mutual contacts are connected to one another (Granovetter, 1992). A high level of structural embeddedness in a network results in members knowing more about the other members of the network and their activities, and diffuses values and norms among the members of the network. In an open source project, structural embeddedness can be measured by the degree to which community members are connected to each other using social network analysis. A square matrix for each of the OSCs will be created from the message postings to record the dyadic ties that occur when members communicate with one another. This data will be used to determine a network density score which summarizes the overall number of relationships in the network.

Relational embeddedness refers to the quality of the dyadic ties within the network, and is suggested by Granovetter (1992) as another important aspect of network structure. Unlike structural embeddedness, which focuses on the number of ties among individuals, relational embeddedness seeks to capture the strength or relational character of the ties between any two individuals, and encompasses such constructs as trust, commitment, and a sense of belonging to the collective (Jones et al., 1997). We propose to measure relational embeddedness by surveying members of OSCs.

Restricted access refers to limiting the number of participants in a network. Restricted access results in more frequent communication between network members and aids in diffusing the shared values and expectations across the network, reducing coordination costs (Jones et al., 1997). The concept of restricted access, which at first glance appears to fly in the face of a volunteer network, is simply a matter of selecting the best volunteers for the tasks that they are capable of (Markus, Manville, & Agres, 2000). We propose to measure restricted access by examining the roles of active participants in each OSC, as given on the Sourceforge website, and taking a ratio of the number of individuals in formal roles to total active participants.

Macroculture refers to the overall culture of the OSC, indicating a sense of shared beliefs, assumptions and values. The role of macroculture is to create typical behavior patterns in order to guide interactions between independent members, shared by all members of a collective (Jones et al., 1997). Macroculture serves to reduce coordination costs by creating shared expectations, a common language for information exchange, and specifying tacit rules for behavior. Although many facets to macroculture may exist, we examine the three constructs of boundary homogeneity, reputational homogeneity and strategic homogeneity proposed by Abrahamson and Fombrum (1994). These constructs will be assessed via survey.

Collective sanctions involve punishing members for noncompliance with the goals, norms, and values of the network (Jones et al., 1997). In open source projects, collective sanctions typically take the form of flaming, spamming, and shunning, which encourage members to leave of their own accord, but may also consist of expulsion, denying access to mailing lists and project development code (to prevent sabotage) (Markus et al., 2000). Collective sanctions will be assessed via survey.

Reputation is defined as a measurement "of one's character, skills, reliability, and other attributes important to exchanges" (Jones et al., 1997, pg. 932). Reputation is an important asset that an individual can leverage to achieve and maintain status within a community of developers and users. Reputation thus serves to safeguard exchanges by detecting and deterring deception. The importance of individual reputation within the collective will be assessed via survey.

Coordination refers to controlling or directing interactions aimed at managing resources and expertise dependencies (Faraj & Sproull, 2000). Although coordination takes time, attention, expertise, and possibly money, adequate coordination of individual efforts within the OSC is crucial to project success. Faraj and Sproull (2000) suggest that coordination in software development projects consists of not only administrative coordination such as managing tangible and economic resources, but also expertise coordination, which involves managing knowledge and skill dependencies. We include measures of both types of coordination in our survey.

Safeguarding is guaranteeing transactions against opportunism (Williamson, 1994). Safeguards are simply mechanisms to ensure that individuals do not engage in opportunistic behavior to the detriment of the collective. In OSCs, safeguarding is likely to occur through strategies for managing conflict, dealing with recurrent issues of negotiation, and establishing rules and procedures regarding exchanges, which we will measure via survey.

Success in OSC projects is somewhat different than success in proprietary software development (Crowston, Annabi, & Howison, 2003). These researchers suggest that OSC success may require separate measures due to open-source development's unique features of free distribution and volunteer developers. They develop a list of objective measures such as the level of activity in a project, time between releases and time required to close bugs, as well as subjective measures such

as developer and member satisfaction with the software. Following their research, we will measure success by examining: the level of project completion as reported on Sourceforge, time between releases, the ratio of bug fixes and feature requests to open bug reports and feature requests, time to close bugs, level of involvement in the project discussion group (number of posts and number of unique individuals), developer satisfaction and user satisfaction.

SUMMARY

In summary, while there has been increased interest around topics of virtual community and online organizing, comparatively little research has been done that examines the organizational structures enabling the coordination and safeguarding of efforts in OSCs. The research question that we focus on is how do OSCs coordinate the actions of volunteers without contracts, hierarchies or formal structures. This paper attempts to extend theories of network governance from the strategy literature to examine the mechanisms underlying coordination and success in open source software development. We present the outline of an empirical investigation to test how the general theory of network governance leads to project success.

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